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Diversification and Stabilization in a Resource-Exporting Country*

by

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Egbert Gerken

1. Introduction

The lion's share of foreign exchange is earned by exporting only one or two primary commodities in a group of countries with small and open economies.[1] While some of them find structural adjustment to an appreciating real exchange rate - brought about by the exploitation of newly-found natural resources or by a secular commodity price hike - painful,[2] the "commodity

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1) By 1980 a single commodity accounted for at least 40 per cent of total export earnings in 60 member countries of the International Monetary Fund, the commodity being crude petroleum, another mining product or an agricultural product in 22, 15, and 23 countries respectively. In all but two of the reporting countries gross domestic product was smaller than in Switzerland, in all but one of the non-oil exporting countries even smaller than in Finland. The ratio of imports to gross domestic product was higher than .20 in all but eight of the 48 reporting countries.
International Monetary Fund 1982. World Bank 1982.

2) The term commodity is used as short-hand expression for primary commodities. Natural resources are defined as essential and specific factors in the production of commodities. Sectors making use of either exhaustible or inexhaustible natural resources are called mining and agricultural sectors respectively.

problem" of old non-oil exporting countries within the group is rather related to instability of world commodity prices and uncertainty about future price trends.[3] Unless caused by supply shifts of the country in question, fluctuating world commodity prices get transmitted into fluctuating export earnings. These are a major potential source for macroeconomic disturbances in the open economy.

To some extent the market narrows down swings in export earnings by encouraging private adjustment to uncertainty. Only ex-post can a commodity price change be identified as either a deviation from some projected price trend or a trend shift. Thus there is an incentive for investors to diversify their portfolio and for suppliers to enter future contracts. The variance in expected returns is reduced this way and risk is shifted to less risk averse international speculators. A problem will arise, if society considers as inacceptable disturbances - domestic price level changes or employment variations - caused by remaining earnings fluctuations. There will then be excess demand for stability as an economic good. Stabilization, however, is not free of cost.

Security might be among the goods foregone. As will be shown, diversifying investments becomes less rewarding under a

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3) Adams and Behrman condense the available information into a few useful indicators. While the fluctuation index for the unit values of manufactured goods increased from 0.0343 in the 1950-69 period to 0.0538 in the 1969-79 period, the index for all primary commodities as a group increased from 0.0479 to 0.1764 between the two periods. The secular real price trend has been negative in the 1950-69 period for all major commodity groups except non-ferrous base metals, but has been positive in the following decade, again with the exception of non-ferrous base metals. The World Bank projects positive real trends up to 1990 for all groups but beverages. These projections, however, are contingent on a multitude of unforeseeable developments. Adams, F.G. and J.R. Behrman 1982, p. 10. World Bank 1980, p. 12.

regime of fixed exchange rates, in particular when foreign exchange reserves or an international compensatory facility are used for financing contra-cyclical policies. As specialization in commodity production increases, the economy is left more vulnerable should a world commodity price decline turn out as permanent. The market, in effect, provides for less security when a specific stabilization policy transfers risk from private economic units to government. In order to regain the good, the authorities might substitute a policy of export diversification - for example taxing commodity exports and subsidizing exports of other goods - for the market solution. The costs of such supplementary measures should then be added to the other costs of the specific stabilization strategy. Export diversification may, however, also be welfare-increasing for reasons other than commodity price uncertainty - serving as first, second or third-best solution to some market imperfection or policy-imposed distortion. The commodity problem would then appear in another light as the severity of earnings fluctuations would be partly due to suboptimal specialization. Removing or compensating for the distortion causing it, excess demand for stability or costs of stabilization policies would also be reduced. If there is a case for export diversification irrespective of the commodity problem, the policy should be applied in any case.

The costs and benefits of export diversification in an old non-oil commodity exporting country are the subject matter of the following analysis. In chapter 2 the causal nexus from commodity price fluctuations to domestic disturbances is developed from well-established macro- and microeconomic theory. As both structural change and multiple distortions are central to the argument, the analysis is promising only in a quantitative multisectoral general equilibrium framework applied to some appropriate country. The case of copper-exporting Chile will be studied here. The country model is described in chapter 3 and documented in the appendix. The model experiments used for determining the costs and benefits are also designed in chapter 3.

The results are presented and discussed in chapter 4 and conclusions are drawn in chapter 5.

2. Disturbances in a Small Commodity Exporting Country

Long-run economic equilibrium is characterized by employment at the natural rate and a balanced foreign exchange account. The properties of short-run equilibria in a small commodity exporting country depend on the exchange rate regime. Consider a temporary decline of the leading export commodity price affecting the economy in a state of long-run equilibrium. The public expects inflation to continue at the equilibrium rate. Labour demand in the commodity sector contracts and unemployment increases unless a falling real wage level allows for additional employment in other sectors.

2.1 The Case of Flexible Exchange Rates

Without government intervention on the foreign exchange market, a shrinking supply of foreign exchange earned by commodity exporters devalues the domestic currency and raises domestic prices of traded goods accordingly. Labour moves into sectors that respond to rising prices by expanding exports or substituting imports. The domestic credit component of money supply can then be directed at the employment or the price level target. As real income earned in the commodity sector falls, the demand for money is reduced. If opportunity costs of holding money remain unaffected, the domestic price level goes up unless the domestic component of money supply is reduced accordingly. The authorities might then try to exploit money illusion by not fully adjusting domestic credit. As additional inflation would come unexpected, the nominal wage claim would remain unchanged in the short-run. The resulting real wage decline would tend to stabilize aggregate employment in spite of contracting labour demand in the commodity sector.

A free foreign exchange market thus facilitates the stabi-

lization of aggregate employment though at the cost of transmitting export earnings fluctuations to the domestic price level and to sectoral employment. Earnings instability is reduced to some extent by portfolio reactions. As rates of return to capital vary inversely between sectors producing traded goods on the one side and the commodity or non-traded goods on the other side, private investors can reduce the risk of an uncertain commodity price trend by accepting a lower internal rate of return on investment in sectors producing traded goods. The remaining earnings instability, however, still creates economic bads. Price level instability reduces the usefulness of money leading the economy nearer to a system of barter: gains from the specialization of a money economy are lost. Structural employment instability adds to informational frictions in the labour market and thus to a higher natural rate of unemployment.[4]

2.2 The Case of Fixed Exchange Rates

Under a fixed exchange rate, a shortfall in earnings drives the foreign exchange account into deficit. Unless outflowing reserves are offset by domestic credit, however, the deficit is automatically eliminated as contracting money supply reduces domestic absorption thereby diminishing import demand and freeing resources for export. Money supply (on account of outflowing reserves) is falling more rapidly than money demand (on account of contracting real income). The price level consequently falls, the real wage level increases and aggregate demand for labour is reduced. If, however, the deficit on current account can somehow be sustained up to a time when the commodity price has recovered, the authorities might attempt to stabilize absorption by expanding domestic credit. This would tend to stabilize the price level and employment as well. The disturbance would in effect be contained within the commodity sector.

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4) Phelps, E.S. 1972.

On the other hand, with the variance in returns to capital eliminated in all but the commodity sector, the rewards of portfolio diversification would be much reduced.

The deficit on current account can, perhaps, be financed by international compensatory finance, the depletion of reserves held for precautionary purposes, or by capital inflow. Compensatory finance is available only in limited amounts. Beyond the limit, the reserve stock would have to ebb and flow in order to stabilize absorption under fluctuating export earnings. The average stock must be enlarged and opportunity costs of reserve-holding must be borne.[5] Provided the capital market has been liberalized, capital inflow could be induced by raising the domestic against the foreign nominal interest rate. With the domestic price level nearly constant, such policy would destabilize the real interest rate thus impairing the efficiency of investment allocation.[6] In the following, only the case of reserve-holding is considered. Implicitly, it is always assumed that the capital market is closed.

An activist demand policy is difficult under fixed rates as the authorities must at the same time intervene in the foreign exchange market. If the public believes that the declared policy cannot be maintained, for example on account of insufficient reserves, speculative capital movements will compel the authorities to give up. In defense of the fixed rate, contraction of real domestic absorption would have to be tolerated till the reserve outflow comes to a halt. Deflation then allows for some recovery of demand. Coming unexpected, however, the real wage claim would increase. In short-run equilibrium, therefore, aggregate employment and output supply fall below the natural rate. Labour demand in sectors producing either the commodity or non-traded goods is reduced without an offsetting

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5) See Tanzi, V. and M.J. Blejer 1982.

6) See Heller, H.R. and M.S. Khan 1978.

expansion in the production of traded goods. In sum: defending the exchange rate against volatile commodity prices but not succeeding in demand management creates costs in terms of aggregate employment fluctuations without stabilizing the domestic price level. The rewards for diversification, furthermore, are smaller than in the case of flexible rates as rates of return to capital do not vary inversely.

2.3 Gains and Losses from a Diversification Policy

Export taxes and subsidies can be applied to compensate for lost market incentives to diversify under fixed exchange rates. Besides the intended risk reduction, such measures would also reduce costs of balancing the movements on the foreign exchange account and would mitigate disturbances in case a contracyclical policy fails. There might, however, also be gains and losses irrespective of the commodity problem. If laissez-faire had assured an optimal trade specialization before, the policy would throw away some of the gains from trade. In commodity-exporting developing countries, however, current specialization often is suboptimal for the following reasons:[7]

(1) National monopoly power in commodity trade leads to unequal rates of domestic and foreign rates of transformation in production, unless there is a sole exporter of the commodity, i.e. a private monopolist. An export tax is the first best solution for exploiting the country's monopoly power.

(2) Import protection has been granted to various "infant" industries which never grew up. The resulting overvalued exchange rate hampers production of other traded goods. Export subsidies are a second best solution, dismantling of protection naturally being first best.

(3) Domestic factor markets are distorted, most notably there are static labour cost differentials between rural and urban

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7) See Corden, W.M. 1974.

regions and between informal and formal sectors.[8] Trade policy can supply a third best solution, while a factor and a production tax-cum-subsidy are first and second best solutions respectively, provided the distortion cannot be removed directly.

If such market imperfections and policy-induced distortions exist and have not been corrected already by other policies, it will not at once be clear whether a specific export tax-cum-subsidy policy will move the economy nearer to the point of optimal specialization or away from it. This can only be determined within a quantitative general equilibrium framework.[9] If the net effect on the variable serving as welfare-indicator turns out as positive, such result will also imply that current export earnings fluctuations are in part originating in market imperfections or policy induced distortions causing suboptimal specialization. Attention should then be directed towards these distortions before turning to stabilization.

3. Analytical Framework

In a recent review of economy-wide model building, Powell (1982) classified such models into the Keynes-Klein, the Philipps-Bergström and the Walras-Johansen tradition. These correspond respectively to time-series models built in the Wharton

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8) See Gerken, E. 1981.

9) Various aspects of the Chilean commodity problem have already been studied within a quantitative general equilibrium framework: Dick et al (1982) on alternative stabilization targets (employment, absorption, exchange rate), Gerken (1983) on using the exchange rate for stabilizing inflationary expectations, Vincent (1982) on the requirements for monetary policy. The present study makes use of the same model. This allows to focus attention on the benefits and costs of export diversification. For a deeper analysis of the implications of alternative reactions to the instability problem, the reader is referred to the previous studies.

tradition,[10] the continuous time disequilibrium model developed at LSE and the applied general equilibrium school. For the subject at hand a model providing projections as distinct from forecasts is required. Its role is to provide insights into how the economy might be influenced by a particular event in the way of identifying the key factors underlying the projections for endogenous variables. For this reason the model should be tightly constrained by conventional economic theory.

The model used here belongs to the Walras-Johansen class paying close attention to microeconomic theory.[11] As such it is particularly appropriate for an open free market economy, explaining trade flows and the composition of domestic activity by relative prices and substitution prospects. Models of this class centre around an input-output system of accounts which facilitates the inclusion of many types of commodity and factor flows: commodity inputs from domestic and imported sources to current production, to capital creation, to households, government and exports, and industry inputs of primary factors which include different types of labour, fixed capital and a sector-specific factor.

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10) For these models, which are formulated in discrete time, relative prices play a minor role by comparison with "activity" variables. For examples see Lasaga (1981) and Adams and Behrman 1982.

11) See Dixon et al. 1982.

The major behavioural postulates are (i) Producers choose their commodity and factor inputs to minimise production costs of a given output subject to three level constant returns to scale industry production functions. At the first level is the Leontief assumption of no substitution between input categories or between them and an aggregate of the primary factors. At the second level are CES functions describing substitution between domestic and imported sources of each input category and between the three primary factors (aggregate labour, fixed capital, natural resources). At the third level are CES functions describing substitution between different occupations within the aggregate labour category. (ii) Households choose their consumption to maximise an additive nested utility function subject to an aggregate budget constraint. The nests of commodity categories contain CES functions describing substitution prospects in consumption between domestic and imported sources of each category.

The comparative-static one period system ignores lags, leads and adjustment dynamics. Hence the model has nothing at all to say about the time path followed by endogenous variables under the influence of an exogenous shock. A short or long-run interpretation can be placed on the adjustment period depending upon the nature of the shock under consideration and the configuration of the economic environment in which it is assumed to take place.

3.1 Sector Disaggregation

Trade flows and variations in the rate of return to capital are central to the subject matter of this study. Sector disaggregation must, therefore, emphasize differences with respect to the export share of domestic production, the import share of domestic demand and the cost shares of factors (see Table 1). On the basis of the 67-sector input-output table of Chile in 1977, the economy is disaggregated into eight sectors

Table 1 Structure of Economic Activity, Production Costs and Trade in Chile 1977

Sector	Sectoral Shares in Total			Cost Shares in Domestic Production							Trade Shares			
	GDP	Workforce	Exports	Copper	Other Intermediates		Labour	Fixed Capital	Natural Resources	Indirect Taxes,Net	Exports[5]	Imports[6]	Relative Wage[7]	Import Protection[8]
					Domestic	Imported								
Agriculture	.103	.079	.054	-	.419	.038	.115	.198	.198	.032	.061	.085	.631	.042
Copper Mining	.066	.065	.464	.067	.290	.094	.204	.171	.171	.003	.836	.036	.920	-
Other Mining	.018	.027	.055	-	.341	.133	.299	.125	.125	-.023	.342	.624	1.095	.050
Food Processing	.081	.066	.076	-	.619	.096	.082	.142	-	.061	.058	.093	.760	.036
Light Manufacturing														
- Import Competing[1]	.080	.090	.039	.010	.490	.142	.149	.154	-	.055	.038	.204	.894	.085
- Export Oriented[2]	.018	.021	.070	-	.593	.055	.137	.196	-	.019	.294	.056	.943	.094
Heavy Manufacturing[3]	.050	.063	.058	.027	.484	.264	.100	.071	-	.054	.064	.494	.952	.104
Services[4]	.584	.589	.184	-	.323	.050	.289	.282	-	.056	.042	.034	1.104	.001

1) Manufacture of consumer good except wood products, cork, and paper. 2) Manufacture of wood products, cork, and paper. 3) All other manufacturing industries. 4) Construction, utilities, distribution, private and public services. 5) Share of exports in total demand for domestic production. 6) Share of imports in total domestic consumption. 7) Ratio of sectoral to economy-wide average wage. 8) Ad valorem rates of import protection.

Source: Presidencia de la República.

each producing one homogeneous good.[12] Natural resource based sectors (agriculture, copper mining, other mining) are distinguished separately. Likewise, a domestic sector characterized by a small export and import share is singled out (services). Activities competing moderately against foreign substitutes (agriculture, food processing) are separated from activities competing strongly, either in the world market (other mining, export oriented light manufacturing) or at home (import competing light manufacturing, heavy manufacturing). Lastly, import competing manufacturing activities are grouped according to different cost shares of imported intermediates.

3.2 System of Equations

The model is written as a set of structural equations linear in all growth rates, allowing it to be solved by simple matrix methods. The equations are listed in Table A1, the variables and coefficients are defined in Tables A2 and A3 respectively. Table A1 partitions the equations into five groups:

(1) Final demands. Households, capital creators, government and foreign sources demand both domestic and imported commodities. Substitution between goods of different source is always induced by changes in relative prices of these goods. The extent of substitution, for a given relative price change, is determined by the specific substitution or cross-price elasticity. Households can substitute between domestic and imported sources of their consumption goods (equation (1)). They can also substitute between different commodity categories within their consumption bundles (2). Producers of capital goods can switch their demand between domestic and imported sources of supply (3). Government demands for imported and domestic commodities are related to real consumption expenditure. Finally, equation (5) indicates that provision is made for Chilean exports to influence world commodity prices.

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12) Presidencia de la República.

(2) Industry Inputs. Chilean industries can substitute between domestic and imported sources of their intermediate inputs, between the primary factors labour, fixed capital, natural resources, and between different labour occupations in producing their outputs (6-9). The extent of substitution for a given change in relative prices is governed by the relevant substitution elasticities.

(3) Zero pure profits. Since constant returns to scale production technology and competitive behaviour is assumed in the derivation of the structural equations, profits can accrue only to factors of production. Industry output prices must equal production costs: intermediate costs from domestic and imported sources, occupational labour costs and fixed capital and land costs (10). The price of a unit of capital creation in each industry must equal its production costs (11). Note that capital creation does involve primary factors indirectly, via their content in intermediate inputs. The selling prices of import commodities must equal the costs of importing (12). Finally, the revenue from exporting must equal the cost of doing so (13).

(4) Market clearing. Supply must equal demand for domestically produced commodities (14), occupational labour (15), fixed capital (16) and natural resources (17). Note that (15)-(17) simply require that factor employment levels are satisfied. Full employment assumptions are not imposed.

(5) Miscellaneous equations. The model includes a large group of equations which are mainly definitional in character. Their structure is for the most part self explanatory. Of these however, equations (22)-(24), which determine the allocation of investment across industries, require further comment.[13] They follow from the assumption that (a) investment takes one period to install,[14] (b) investors have an expected rate of return

13) See also Dixon et al 1982.

14) Since the model is of a one period comparative-static nature, this means that endogenous investment in the model's solution period does not augment the economy's capital stock in that period.

schedule from new investment which is downwards sloping and (c) aggregate investment is allocated across industries to equate expected rates of return.

The monetary equilibrium need not be made explicit in the model. The authorities are assumed to vary domestic credit supply so as to secure the imposed employment, absorption or exchange rate target given changes in money demand and in the foreign component of money supply.

3.3 Experiments

The analysis proceeds by a set of comparative-static model experiments. In each experiment, the conditions for a specific equilibrium are imposed via the model closure, i.e. by assigning values to a selection of exogenous variables (see Table A4). From Tables A1 and A2 we see that there are $4gh + 11g + 9h + rh + 2r + 13$ equations in $4gh + 15g + 11h + rh + 2r + 17$ variables. The model is first closed by assigning values to a selection of $4g + 2h + 4$ variables. Solution values for the endogenous variables are then obtained by matrix methods. The solution matrix gives percentage deviations of all endogenous variables from the values which would have occurred without the commodity price change or the diversification policy. In Table 2 a selection of macroeconomic, trade, and sector employment solutions necessary for reaching conclusions is presented.

The first experiment is designed so as to explore the net social costs of an export tax-cum-subsidy policy irrespective of the commodity problem. A 10 per cent ad valorem tax on copper exports and a 10 per cent ad valorem subsidy on the export of all goods but services and products of heavy manufacturing is introduced or added to existing taxes or subsidies. Export quantities of other goods are fixed in all experiments.[15]

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15) See footnote 2 to Table A4.

The structural change is expected in the long-run. Labour as well as capital, therefore, move equalizing sectoral factor prices. Real wages adjust so as to allow only natural unemployment. The labour force is kept constant and there is no shift in world copper demand. The solution for real GDP then shows the net real income effect of the diversification policy. Real income is used as the sole welfare indicator, i.e. a positive result for GDP is interpreted as a welfare gain or as indicating negative net social costs of the diversification policy. The sectoral solutions for employment, capital stocks, exports and imports quantify the structural change induced by the policy. These solutions together with the solution for total investment are used to construct the data base for the model describing the economy after structural change has taken place. Each of the following stabilization policy experiments can then be carried through both for the undiversified and for the diversified economy. Comparing solutions, the contribution of the export tax-cum-subsidy can be studied.

All instability experiments have in common the copper price decline and the short-run perspective. A rather drastic copper price shock of -41.37 p.c. is introduced for the following reason. A variation of the reserve stock is considered here as the only means of financing a deficit in current account. In order to secure credibility for their contra-cyclical policy and to prevent speculative capital movements, the authorities must visibly plan the average reserve-stock for the worst expected case. A price decline of the size of the average deviation from the moving five-year-average of the last decade (1970-79) plus two standard deviations has been defined here as the worst expected case. [16] Under normal distribution this would exclude an even more dramatic decline with a probability of 95 per cent. The short-run perspective is characterized by intersectoral capital immobility and by the possibility of unexpected price

16) World Bank 1980, p. 310.

level changes. All short-run model closures exogenously fix sectoral capital stocks and money wage.

The second experiment is designed to bring out the implications of stabilizing aggregate employment under flexible exchange rates. The imposed short-run equilibrium is characterized by a constant balance on current account and by employment at the natural rate. The solutions then show the currency depreciation, the price level increase and sectoral employment changes. The third experiment attempts demand management under fixed exchange rates. The model is now closed by fixing real domestic absorption as well as the nominal exchange rate exogenously allowing the current account to move into deficit. The solutions permit an assessment of the stabilization effects and of the reserve stock required for financing the current account deficit. The opportunity costs of reserve-holding are calculated outside the model. The fourth experiment is intended to study the instability effects under fixed rates without demand management. The model is closed by fixing the balance on current account and the nominal exchange rate.

4. Results

4.1 Export Diversification

The macroeconomic, trade, and sector employment solutions necessary for reaching conclusions are presented in Table 2. The following interpretation makes extensive use of the cost and trade structure data of the base year collected in Table 1 without at each occasion referring to the Table explicitly.

The first experiment introduces a 10 per cent ad valorem tax on copper exports and a 10 per cent ad valorem subsidy on all other exports except services and products of heavy manufacturing. The experiment allows time for labour and capital to move between sectors, though the specific factor naturally can-

not leave agriculture or mining. Copper exports drop by 10.58 per cent in quantity but, owing to Chile's monopoly position, by only 5.24 per cent in foreign currency value. While total export earnings grow by 8.03 per cent following the subsidized expansion of non-copper exports, the share of copper in total exports goes down from 46 to 40 per cent. The real income effect is positive: real GDP is enlarged by 1.43 per cent.

The real income effect must be examined for the underlying distortions, though an exact separation of the general equilibrium result into its elements is not possible. First, observing different export demand elasticities for copper and for all other goods (2 and 20 respectively) as well as infinite supply elasticities for all imports, an appreciation of the Terms of Trade by 1.86 per cent can be calculated from the copper share in total exports (0.46) and the model results for copper and aggregated non-copper export quantities (-10.58 per cent and 20.35 per cent respectively). Weighted by the trade share, the Terms of Trade improvement adds 0.54 per cent to GDP. If no other distortion was included in the model and the data base was describing a country currently exploiting its monopoly power, this outcome would be swamped by the negative income effect of raising marginal copper revenues above marginal costs of supply. Current exploitation must be embodied in the data base as indirect tax or as pure profit in copper production. Since virtually the whole copper output is exported or used as own intermediate, net indirect taxes reduce the domestic price in much the same way as pure export taxes do. The net indirect tax rate on copper output, however, is only 0.003 in the base year. Pure profits, if they existed, would be merged with rental payments to owners of natural resources in the data base. The profit rate, which would be smaller than the earnings share accruing to the sector-specific factor (0.17), must be compared to the optimum export tax rate, which is equal to the reciprocal of the export demand elasticity after imposing the optimum trade

Table 2 Effects of Export Diversification and Alternative Policy Reactions to a Shortfall in World Copper Demand [1]

Variable	Experiment 1	41.37 per cent world copper price decline (short-run closure)[9]					
		Experiment 2		Experiment 3		Experiment 4	
	Export tax-cum-subsidy[5] (long-run closure)[9]	Flexible exchange rates and fixed aggregate employment		Fixed exchange rates and fixed real domestic absorption		Fixed exchange rates and fixed balance on current account	
		U[7]	D[8]	U	D	U	D
Macroeconomic							
Real GDP	1.43	-4.50	-3.53	-5.71	-4.67	-7.56	-6.00
Real domestic absorption	1.43	-4.50	-3.53	O(EX)	O(EX)	-7.56	-6.00
Aggregate employment	O(EX)[6]	O(EX)	O(EX)	-1.17	-1.33	-7.18	-5.56
Exchange rate							
- nominal	O(EX)	8.19	6.01	O(EX)	O(EX)	O(EX)	O(EX)
- real	-6.74	5.02	3.53	0.28	0.33	4.50	3.37
Domestic price level[2]	6.74	3.17	2.47	-0.28	-0.33	-4.50	-3.37
Wage -nominal	9.12	O(EX)	O(EX)	O(EX)	O(EX)	O(EX)	O(EX)
- real	2.43	-3.17	-2.47	0.28	0.33	4.50	3.37
Trade[3]							
Balance of current account	O(EX)	O(EX)	O(EX)	-634	-562	O(EX)	O(EX)
Aggregate imports	8.03	-8.20	-5.90	-0.94	-1.05	-10.64	-8.16
Aggregate exports	8.03	-8.20	-5.90	-20.75	-17.33	-10.64	-8.16
Copper exports	-5.24	-45.24	-47.05	-45.63	-50.00	-45.26	-49.52
Non-copper exports	19.33	23.35	29.15	0.44	4.45	18.85	19.41
Sector Employment[4]							
Agriculture	1.11	4.96	3.72	0.12	0.19	0.84	0.82
Copper mining	-13.59	-16.75	-21.84	-20.03	-24.86	-19.38	-24.15
Other mining	8.97	21.94	16.05	0.43	0.64	6.58	5.23
Food processing	1.04	6.39	6.63	0.15	0.26	-2.31	0.12
Light manufacturing							
- import competing	0.39	7.98	8.58	0.84	1.02	-2.44	0.49
- export oriented	16.60	21.59	16.46	0.47	0.79	8.63	7.48
Heavy manufacturing	-6.53	6.36	4.85	2.22	1.85	-2.19	-1.62
Services	0.83	-3.22	-2.45	-0.22	-0.34	-9.93	-7.70
Total change in work-places	2.60	5.98	5.37	1.71	1.87	8.05	6.49

1) Model projections. All projections are in percentage changes with the exception of the balance of current account which has the unit of millions of US dollars (1977). 2) Consumer price index. 3) In foreign currency value. 4) For sector disaggregation see footnotes to Table 1. 5) 10 per cent ad valorem tax on exports from copper mining, 10 per cent ad valorem subsidy on exports from all sectors except copper mining, heavy manufacturing and services. 6) Denotes variable exogenously set to zero. 7) Model in base year. 8) Model after updating base year data according to results of experiment 1. 9) The time interpretation of short- and long-run is somewhat vague. In the short-run nominal wage claims and industry capital stocks are fixed, in the long-run they are flexible. The distinction is thus between periods not exceeding the time lag on the adjustment of expectations and the gestation lag on new investment and periods exceeding both lags.

Source: Own Calculations.

tax structure.[17] Though the point elasticity of copper export demand (2) would certainly increase in this process, there remains a strong impression that monopoly power is not fully exploited in the base year. In the model, pure profits are denied by imposing constant returns to scale, i.e. the contribution of improved Terms of Trade to GDP is not impaired.

Second, a rather large residual real income effect remains to be accounted for by the two other distortions included in the model: static labour cost differentials and import protection. For decomposing, structural change in employment and thus also in output must be considered first. Sectoral solutions presented in Table 2 are both the direct result of export taxes and subsidies and the indirect result of an appreciation of the real exchange rate (6.74 per cent) caused by real income growth. The diversification policy does not simply increase activity in other international sectors at the expense of copper mining. The appreciation fosters employment in services, it furthermore lowers relative prices of imported goods. Net sectoral effects then depend on trade shares. High export shares in domestic production and low import shares in domestic consumption give occasion to strong expansions in other mining and in export oriented light manufacturing, whereas the reverse constellation hinders entrepreneurs in import competing light manufacturing to take advantage of export subsidies. Contraction of heavy manufacturing employment is due to both falling prices of imports which account for 49 per cent of domestic consumption and to the withholding of export subsidies.

Static labour cost differentials have an impact on model solutions, since average wages per employed differ between sectors and the intersectoral wage ratios are kept constant. As wages per employed in contracting sectors (copper mining, export

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17) Corden, W.M. 1974, p. 169.

manufacturing), however, are near the economy-wide average and labour moves into above- as well as below-average wage sectors, restructuring of employment carries no efficiency gains. Weighted by the economy-wide value added share of labour (41 per cent), there is even a small real income loss of about 0.02 per cent. The positive residual income effect must thus be attributed to the effect of compensating for current import protection and for the overvaluation of the exchange rate implied by it. Specifically, the highest protection is granted to heavy manufacturing both directly by tariffs and indirectly by the undervaluation of imported intermediates.

4.2 Instability under Flexible Exchange Rates

In experiment 2 the authorities are assumed to direct domestic credit at the employment target. As real income drops by 4.50 per cent following the copper price shock also money demand is shrinking. The simulation result shows that in order to achieve the real wage decline necessary for constant employment, the price level must be allowed to rise by 3.17 per cent against the expected inflation rate. Domestic credit supply, accordingly, must not be adjusted to the lower demand for money.

The structural change required for balancing the current account and employing all labour dismissed from copper mining is brought about by the currency depreciation of 8.19 per cent. After domestic inflation this is translated into a real exchange rate devaluation of 5.02 per cent stimulating non-copper exports and contracting all imports. Employment is reduced in the commodity and in the domestic sector, that is copper mining and services. All manufacturing sectors gain in employment as do agriculture and other mining. Export oriented sectors (other mining, export oriented light manufacturing) expand more than import substituting sectors as the price elasticities of export demand are substantially above those of import demand.

Large changes in sectoral labour demand may raise some

doubts as to whether supply is flexible enough to ensure constant aggregate employment. In semi-industrial countries a high percentage of total workforce is known to be waiting or searching for work at any time.[18] Additional labour demand can be met to some extent by workers living on the location. Structural employment instability rather makes the search for work even more attractive and thereby increases the rate of natural unemployment. Sectoral dismissals and hirings have been aggregated in Table 2 in order to provide an indicator for structural instability. As contraction or expansion of sectoral labour demand are determined by trade and cost structures, and the model has been disaggregated homogeneously in this respect, the indicator is unbiased. 2.99 per cent of labour force are dismissed from work and an equal percentage are hired.

Provided an export tax-cum-subsidy policy had led to the structural changes described in experiment 1, the copper price change would less affect the inflation rate (2.47 per cent) and would require a smaller amount of work-place switching (5.37 per cent) for keeping aggregate employment constant. Employment in the copper mining sector, however, is shown to be more sensitive to copper price changes, as diversification has lowered the production share of labour in copper mining. Adjusting factor inputs to output changes now requires a higher rate of change in the employment of the variable factor than before.

A flexible exchange rate regime encourages private diversification. As sectoral capital-stocks are fixed in the short-run closures of the model, the structure of employment changes also gives an indication of the structure of changes in return to capital. Private investors can reduce the variance in expected returns by expanding investment in export oriented sectors other than copper mining. Since this process has not been included in the model, the solutions both with and without the export-

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18) See Berry, A. and R.H. Sabot 1978. In Chile the unemployment rate reached a low of 12 per cent in 1980-81 before the economic depression began.

cum-subsidy overstate the instability under flexible exchange rates.

4.3 Opportunity Costs of Stabilization under Fixed Exchange Rates

In the third experiment, the nominal exchange rate is defended against falling copper prices, and expansionary policies are implemented to cut the link between real income and real domestic absorption. The benefits of demand management under fixed rates, if successful, are shown by the solutions. The disturbance is contained within the commodity sector. There is only a slight decrease in the price level as credit expansion almost compensates for the difference between a contracting foreign component of money supply and shrinking money demand. Aggregate unemployment is mainly due to lay-offs in copper mining. Dismissals and hirings affect only 1.71 per cent of labour force. As also returns to capital are stabilized outside the copper sector, incentives for portfolio diversification are much reduced.

Costs arise from the necessity to finance a current account deficit of 634 Mill. US Dollar or 5.5 per cent of GDP as imports and non-copper exports remain almost unchanged after the copper price decline. If the authorities keep an additional average reserve stock for balancing the variations on current account induced by commodity export earnings, the society will have to bear the opportunity costs of returns foregone from alternative uses - like, for example, from investments into the domestic fixed capital stock or from smaller long-run debt commitments to international financial markets. As interest on these debts is higher than the interest that can be earned by holding the reserve in short-run foreign securities (for example in US treasury bills), the opportunity costs are positive.

The policy of export diversification cannot add to the stability of the macroeconomic variables as real domestic absorption has been fixed in both experiments with and without the

structural change. The higher sensitivity of employment in the copper sector due to diversification even increases slightly the remaining instabilities. Reserve requirements fall to 562 Mill. US Dollars. Evaluating the opportunity costs of holding additional reserves with the interest rate differential between the country's long-run debt commitments and US treasury bills - about 3.6 per cent in the average between 1975 and 1980[19] - and comparing results, it becomes obvious that only a small cost reduction (2.6 Mill. US Dollars) is achieved. The main benefits of diversification are lying elsewhere.

4.4 Instability under Fixed Exchange Rates

Defending the nominal exchange rate against a deteriorating copper price without being equipped or willing to finance a deficit in the current account, the authorities must put up with a heavy contraction in domestic absorption. The solutions of experiment 4, in which this case is simulated, can be interpreted most conveniently in comparison with those of experiment 2 simulating the case of employment stabilization under flexible rates. Shrinking money supply now takes down the domestic price level by 4.50 per cent below the inflation rate expected in long-run equilibrium. Instead of a real wage decline by 3.17 per cent as required for constant aggregate employment, the claim is unintendedly increased by deflation. Employment consequently falls 7.18 per cent below the natural rate.

Fixing the nominal rate has only a minor stabilizing effect on the real exchange rate (-4.50 per cent instead of -5.02 per cent under flexible rates). Comparing structural results of both experiments, it can thus be seen that employment losses are distributed over all sectors, i.e. expansionary movements are

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19) World Bank 1981, pp. 130-132. International Monetary Fund 1982.

mitigated and contractionary movements aggravated. This shifts the instability from sectors expanding on behalf of the real exchange rate devaluation to those contracting, i.e. from the international sectors to both the commodity and the domestic sector. In industries producing traded goods except copper, export expansion and import displacement are impaired by a shrinking domestic demand. In the mainly import competing sectors, the net employment effect even turns negative. Consequently, there is less incentive for diversifying investments in favour of the production of traded goods other than copper. Finally, with labour intensity in the domestic sector on average higher than in the international sectors - the value added share of labour is .46 in services but only .35 in the rest of the economy - shifting employment instability to the domestic sectors increases structural instability in total. Following the model simulation, 8.05 per cent instead of 5.98 per cent of labour force move either in or out of work places. Waiting and searching for work becomes more rewarding.

The export tax-cum-subsidy policy cuts down costs of defending the nominal exchange rate. Since total export earnings fluctuate less heavily, a balanced current account requires smaller changes in absorption. In the worst case, the domestic price level falls by 3.37 instead of by 4.50 per cent. A less volatile real exchange rate implies a smaller amount of hirings and dismissals: 6.49 instead of 8.05 per cent of the labour force are involved. Still, comparing fixed to flexible exchange rate solutions in the diversified economy, the instability of all variables but the nominal exchange rate - aggregate employment, domestic price level, structural employment - turns out smaller in the case of flexible exchange rates.

5. Summary and Conclusions

Instability of world commodity markets brings about macroeconomic disturbances in a group of countries earning their fo-

reign exchange to substantial parts by exporting just a few primary commodities. The authorities of such countries can stabilize aggregate employment against external shocks by reserving monetary policies for that purpose, allowing the currency to find its price in the foreign exchange market. Export earnings fluctuations, however, will then cause domestic price level and sectoral employment fluctuations. Such adverse implications could be avoided within a fixed exchange rate regime, if the authorities were to succeed with attempts to stabilize real domestic absorption.

Fixing the nominal exchange rate, however, market incentives for export diversification are subdued as no longer do returns to capital vary inversely between sectors producing the commodity as well as non-traded goods on the one side and other international sectors on the other side. Less diversified, the economy is then exposed to wider export earnings fluctuations and to greater risks of shifting commodity price trends. The authorities might substitute export taxes-cum-subsidies for the market incentives in order to temper swings in earnings and regain security.

In the first experiment it was shown that a marginal export tax-cum-subsidy policy has a positive welfare effect irrespective of the instability and uncertainty issue. Real income is increasing. The result was crudely decomposed into a monopoly and an import protection effect, i.e. the measures turned out as solutions to current distortions. It follows that the instability of domestic variables is in part due to domestic distortions. Correcting for such distortions first, excess demand for price level and structural employment stability would be reduced. The case for stabilizing within a fixed exchange rate regime is then less convincing.

In the second experiment some implications of aggregate employment stabilization within a flexible exchange rate regime

were quantified first within the undiversified economy. The solutions revealed that domestic price level and structural employment instability would indeed be high in such a case. Price level instability, however, is remarkably reduced already by the marginal diversification obtained in experiment 1. It must be kept in mind, furthermore, that portfolio diversification is not included in the model, i.e. the economy of the model is less diversified than after a period of adjustment to a flexible exchange rate regime. The indicators, therefore, overstate the instability relative to the fixed exchange rate cases.

In the third experiment, the authorities defend the exchange rate and stabilize real domestic absorption - relying on a stock of reserves built up for that purpose. Domestic price level, aggregate and structural employment can, as the model results confirm, indeed be stabilized to a large extent. Diversification would in such case have only little additional effect besides reducing the risk of stabilizing with respect to erroneous price projections. Opportunity costs of reserve-holding are reduced but by a small amount. In spite of high reserves, however, doubts persist whether the authorities of commodity-exporting countries can avoid speculative capital movements in face of drastic changes in the balance of current account after a copper price shock.

In the fourth experiment, therefore, the implications of defending the exchange rate without financing a current account deficit were examined. External equilibrium must then be obtained by massive deflation including a dramatic decline of employment. Both price level and structural employment stability are shown to be higher than in the case of flexible rates. By reducing fluctuations in export earnings, the export tax-cum-subsidy measure mitigates each of these adverse effects. In each case, however, the instability remains higher than under a flexible exchange rate system, in which monetary instruments are reserved for aggregate employment stabilization.

The task of determining the structural effects of a complete removal or correction of distortions has not been taken up here. Nor was private reaction to uncertainty included in the model. The quantitative results of this study nevertheless lead to the conclusion that the case for reacting to export earnings fluctuations by stabilization within a fixed exchange rate regime is not a strong one.

Finally, the paper has illustrated how a formal economy-wide framework can be used to assist policy makers in evaluating the implications of alternative proposed policies. As with all studies of an applied nature the results are conditional on (a) the numerous assumptions underlying the economic structure of the model used, and (b) the quality of the data used to specify the model numerically. The assumptions have been made explicit, as far as is possible, to enable the reader to judge their relevance. With respect to data, no effort has been made to assess the quality of the published sources. Least defendable, probably, is the assumption of a constant export demand elasticity in the case of an export diversification policy. The elasticity is more likely to increase thus removing the possibility of exploiting monopoly power. Note, however, that the monopoly effect accounted for the smaller part of the positive income result only. The compensation for trade distortions or the direct removal of these distortions will nevertheless lead to both higher real income and a more diversified economy. The beneficial effects of such diversification under commodity market instability have been worked out quantitatively. While the numerical projections have obvious limitations, they assist in arriving at the dimensions of policies required to cope with the external shock given specified targets.

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Table A1 The Chilean Model Equations: A Linear System in Percentage Changes[1]

Identifier	Equation[2,3]	Subscript Range	Number	Description
	1. Final Demands			
(1)	$x^{(3)}_{is} = x^{(3)}_{i} - \sigma^{(3)}_{i}(p_{is} - \sum_{s=1}^{2} S^{(3)}_{is}\, p_{is})$	i=1,...,g s=1,2	2g	Household demands for commodities by source
(2)	$x^{(3)}_{i} = q + \varepsilon_i(c - q) + \sum_{k=1}^{g} \eta_{ik}\, p_k$	i=1,...,g	g	Household demands for commodities undifferentiated by source
(3)	$x^{(2)}_{(is)j} = y_j - \sigma^{(2)}_{ij}(p_{is} - \sum_{s=1}^{2} S^{(2)}_{(is)j}\, p_{is})$	i=1,...,g s=1,2 j=1,...,h	2gh	Demands for inputs to capital creation
(4)	$x^{(5)}_{is} = c_R$	i=1,...,g s=1,2	2g	Other (mainly government) demands
(5)	$p^{e}_{i} = -\gamma_i\, x^{(4)}_{i1} + f^{(4)}_{i1}$	i=1,...,g	g	Export demands
	2. Industry Inputs			
(6)	$x^{(1)}_{(is)j} = z_j - \sigma^{(1)}_{ij}(p_{is} - \sum_{s=1}^{2} S^{(1)}_{(is)j}\, p_{is})$	i=1,...,g s=1,2 j=1,...,h	2gh	Demands for intermediate inputs
(7)	$x^{P}_{vj} = z_j - \sigma^{P}_{j}(p^{P}_{vj} - \sum_{v=2}^{3} S_{vj}\, p^{P}_{vj} - S_{1j}\, p^{P}_{1})$	v=2,3 j=1,...,h	2h	Demands for fixed capital (v=2) and land (v=3)
(8)	$x^{P}_{1j} = z_j - \sigma^{P}_{j}(p^{P}_{1} - \sum_{v=2}^{3} S_{vj}\, p^{P}_{vj} - S_{1j}\, p^{P}_{1})$	j=1,...,h	h	Demands for aggregate labour
(9)	$x^{P}_{1,q,j} = x^{P}_{1j} - \sigma^{P}_{1,j}(p^{P}_{1,q} - \sum_{q=1}^{r} S_{1,q,j}\, p^{P}_{1,q})$	q=1,...,r j=1,...,h	rh	Demands for labour of each occupation
	3. Zero Pure Profits Conditions			
(10)	$p_{j1} = \sum_{i=1}^{g}\sum_{s=1}^{2} H^{(1)}_{(is)j}\, p_{is} + \sum_{q=1}^{r} H^{P}_{1,q,j}\, p^{P}_{1,q} + \sum_{v=2}^{3} H^{P}_{vj}\, p^{P}_{vj} + H^{T}_{j}\, p_{j1}$	j=1,...,h	h	- in production
(11)	$\pi_j = \sum_{i=1}^{g}\sum_{s=1}^{2} H^{(2)}_{(is)j}\, p_{is}$	j=1,...,h	h	- in capital creation
(12)	$p_{i2} = p^{m}_{i2} + t_i + \phi$	i=1,...,h	g	- in importing
(13)	$p_{i1} = p^{e}_{i} + v_i + \phi$	i=1,...,g	g	- in exporting
	4. Market Clearing			Supply equals demand for
(14)	$z_j = \sum_{j=1}^{h} B^{(1)}_{(i1)j}\, x^{(1)}_{(i1)j} + \sum_{j=1}^{h} B^{(2)}_{(i1)j}\, x^{(2)}_{(i1)j} + B^{(3)}_{i1} x^{(3)}_{i1} + B^{(4)}_{i1}\, x^{(4)}_{i1} + B^{(5)}_{i1}\, x^{(5)}_{i1}$	j=1,...,g	g	- domestically produced commodities
(15)	$\ell_q = \sum_{j=1}^{h} B_{1,q,j}\, x^{P}_{1,q,j}$	q=1,...,r	r	- labour of each occupation
(16)	$k_j = x^{P}_{2j}$	j=1,...,h	h	- capital
(17)	$n_j = x^{P}_{3j}$	j=1,...,h	h	- land

Table A1 continued The Chilean Model Equations: A Linear System in Percentage Changes [1]

entifier	Equation	Subscript Range	Number	Description
	5. Miscellaneous			
(18)	$x_{i2} = \sum_{j=1}^{h} B^{(1)}_{(i2)j} x^{(1)}_{(i2)j} + \sum_{j=1}^{h} B^{(2)}_{(i2)j} x^{(2)}_{(i2)j}$ $B^{(3)}_{i2} x^{(3)}_{i2} + B^{(5)}_{i2} x^{(5)}_{i2}$	i=1,...,q	q	Competitive import volume
(19)	$m = \sum_{i=1}^{q} (p^{m}_{i2} + x_{i2}) M_{i2}$		1	Foreign currency imports
(20)	$e = \sum_{i=1}^{q} (p^{e}_{i1} + x^{(4)}_{i1}) E_{i1}$		1	Foreign currency exports
(21)	$100\Delta R = Ee - Mm$		1	Balance of current account
(22)	$r_j = Q_j (p^{p}_{2j} - \pi_j)$	j=1,...,h	h	Rate of return to capital
(23)	$y_j = k_j + B_j (r_j - \lambda)$	j=1,...,h	h	Industry investment
(24)	$\Sigma_j (\pi_j + y_j) T_j = i$		1	Investment budget (nominal)
(25)	$p^{p}_{1} = \sum_{q=1}^{r} p_{1,q} S_{1,q}$		1	Price of labour in general
(26)	$p_k = \sum_{s=1}^{2} S^{(3)}_{ks} p_{ks}$	k=1,...,g	g	General price of goods to households
(27)	$\epsilon^{(3)} = \sum_{i=1}^{g} \sum_{s=1}^{2} W^{(3)}_{is} p_{is}$		1	Consumer price index
(28)	$\epsilon^{(2)} = \sum_{j=1}^{h} T_j \pi_j$		1	Capital goods price index
(29)	$c_R = c - \epsilon^{(3)}$		1	Aggregate real consumption
(30)	$i_R = i - \epsilon^{(2)}$		1	Aggregate real investment
(31)	$i_R = c_R$		1	Relationship between real consumption and investment
(32)	$\ell = \sum_{q=1}^{r} \ell_q \psi_{1q}$		1	Aggregate employment
(33)	$\kappa = \sum_{j=1}^{h} k_j \psi_{2j}$		1	Aggregate capital stock
(34)	$p^{p}_{1,q} = f_1$		r	Allows for exogenous setting of wages
(35)	$gdp = S_c c_R + S_i i_R + S_g \left(\sum_{s=1}^{2} \sum_{i=1}^{g} x^{(5)}_{is} S^{(5)}_{is} \right)$ $+ S_e e - S_m m$		1	Gross domestic product

otal equations = 4gh + 11g + 9h + rh + 2r + 13

1) The variables and coefficients are defined in Tables A2 and A3.

2) The model distinguishes 8 domestic industries each producing its respective commodity i.e., g and h = 8. Hence $p_{j1} = p_{i1}$, j = 1,...,h, i = 1,...,g. (Labels for these are given in Table 1). The labour market is divided into two occupational categories, i.e., r = 2. The superscript s denotes the source of the commodity, s = 1 (domestically produced), s = 2 (imported). The superscript v denotes the type of primary factor; v = 1 (aggregate labour), v = 2 (fixed capital), v = 3 (land).

3) The nomenclature of variable superscripts is as follows. Superscript "P" denotes a primary factor quantity or price, superscript "m" a foreign price for imports (cif) and superscript "e" a foreign price for exports (fob). Superscript (1) denotes the use of that variable in current production, (2) in capital creation, (3) by households, (4) exports and (5) by other (mainly government) demands. Note that there is no superscript on the local prices of domestic and imported commodities (the p_{is}). That is, the price of a commodity is assumed to be the same in all domestic end uses.

Table A2 Chilean Model Variables

Variable [1]	Number	Description [2]
$x^{(3)}_{is}$	2g	Household demands for domestic and imported goods
$x^{(3)}_{i}$	g	Household demands for goods undifferentiated by source
p_{is}	2g	Price of good i from source s
q	1	Number of households
c	1	Aggregate nominal household expenditure
p_{k}	g	Price of consumer goods by type but not by source
$x^{(2)}_{(is)j}$	2gh	Demands for inputs (domestic and imported) for capital creation
y_{j}	h	Capital creation by using industry
$x^{(5)}_{is}$	2g	Other (mainly government) demands for domestic and imported goods
c_{R}	1	Aggregate real household expenditure
p^{e}_{i}	g	F.o.b. foreign currency export prices
$x^{(4)}_{i1}$	g	Export demands
$f^{(4)}_{i1}$	g	Export demand shift variable
$x^{(1)}_{(is)j}$	2gh	Demands for inputs (domestic and imported) for current production
z_{j}	h	Industry outputs
x^{p}_{vj}	3h	Industry demands for labour in general, fixed capital and land
p^{p}_{vj}	2h	Rental prices of capital (v=2) and land (v=3) in each industry
p^{p}_{1}	1	Economy wide price of labour in general
$x^{p}_{1,q,j}$	rh	Demands for labour by occupation and industry
$p^{p}_{1,q}$	r	Price of labour by occupation
π_{j}	h	Costs of units of capital
p^{m}_{i2}	g	C.i.f. foreign currency prices for competing imports
t_{i}	g	One plus the ad valorem rates of protection on imports
ϕ	1	Exchange rate (Chilean peso/foreign currency ($ US))
v_{i}	g	One plus ad valorem rates of export subsidies
ℓ_{q}	r	Employment by occupation
k_{j}	h	Industry capital stocks
n_{j}	h	Industry land

Table A2 continued Chilean Model Variables

Variable [1]	Number	Description [2]
$\epsilon^{(3)}$	1	Consumer price index
gdp	1	Gross domestic product
ΔR	1	Balance of current account
x_{i2}	g	Commodity import volumes
m	1	Foreign currency value of imports
e	1	Foreign currency value of exports
r_j	h	Industry rates of return to capital
λ	1	Economy-wide expected rate of return
i	1	Aggregate nominal investment
$\epsilon^{(2)}$	1	Investment goods price index
i_R	1	Aggregate real investment
ℓ	1	Aggregate employment
κ	1	Economy's aggregate capital stock
f_1	1	Shift term for economy-wide wage

Total variables: $4gh + 15g + 11h + rh + 2r + 17$

1) The variable subscript range is as follows: $i,k = 1,\ldots,g$; $s = 1,2$; $v = 1,2,3$; $j = 1,\ldots,h$; $q = 1,\ldots r$.

2) All variables are in percentage changes except the balance of current account, ΔR, which, because it can move through zero, is expressed in first differences.

Table A3 Coefficients of the Chilean Model

$\sigma_i^{(3)}$, $\sigma_{ij}^{(1)}$, $\sigma_{ij}^{(2)}$

CES import-domestic substitution elasticities for good i in household consumption ($\sigma_i^{(3)}$), intermediate usage in industry j for current production ($\sigma_{ij}^{(1)}$), and as inputs to capital creation ($\sigma_{ij}^{(2)}$). A common value of 2.0 was assigned to all these elasticities. This value, while judgemental, is consistent with estimates from the few published studies in this area.

σ_j^P, $\sigma_{1,j}^P$

CES substitution elasticities among primary factors (σ_j^P), and amongst occupational labour ($\sigma_{1,j}^P$) in industry j. Since relative wages between occupations were assumed fixed in all experiments the values assigned to $\sigma_{1,j}^P$ (1.0 for all j), exert no influence on the results. The following values for σ_j^P were used, 1. Agriculture (0.31), 2. Copper mining (0.20), 3. Other mining (0.51), 4. Food processing (1.0), 5. Light manufacturing (import competing) (1.0), 6. Light manufacturing (export oriented) (1.0), 7. Heavy manufacturing (1.0), 8. Services (0.43). The values for sectors 1,3 and 8 were drawn from the econometric estimates in Behrman (1972), the value for sector 2 from the supply elasticity reported in Lasaga (1981). Values for the remaining sectors are based on the estimates reported in Corbo and Meller (1979).

ε_i, η_{ik}

Expenditure (ε_i) and cross price (η_{ik} $i \neq k$) elasticities in household consumption for good i. Estimates for ε_i were obtained from the Chilean household demand studies reported in Lluch, Powell and Williams (1977) and Taborga (1978). The estimates used for each of the eight commodity groups are, 1. (0.60), 2.-4. (0.75), 5. (1.10), 6. (1.41), 7. (1.62), 8. (1.18). Since the underlying household utility functions are assumed to be additive, the matrix of uncompensated own price (η_{ii}) and cross price (η_{ik}) consumer demand elasticities were obtained from

Table A3 continued Coefficients of the Chilean Model

$$\eta_{ii} = \frac{\varepsilon_i}{w} - \varepsilon_i \alpha_i \left(1 + \frac{\varepsilon_i}{w}\right)$$

$$\eta_{ik} = - \varepsilon_i \alpha_j \left(1 + \frac{\varepsilon_j}{w}\right) \qquad i \neq k$$

Where w is the Frisch parameter and α_j are household budget shares calculated from the 1977 input output table. The estimate of w (-2.525) was obtained using the relationship between per capita GDP and Frisch parameter values estimated by Lluch, Powell and Williams (1977).

γ_i Reciprocals of the foreign demand elasticities for Chilean export commodity i. For all commodity categories except copper, the "small country" assumption was approximated by assigning a small value (0.05) to the respective γ_i's. For copper, a value of 0.5 was used. This value is based principally on the world price elasticity of demand for copper and the Chilean share in world copper exports.

Q_j Industry investment parameters. Q_j is the ratio of the gross (before depreciation) to the net (after depreciation) rate of return in industry j. B_j is the reciprocal of the elasticity B_j of the expected rate of return schedule for industry j times T_j the ratio of its gross investment to its following year capital stock. T_j is the share of total investment accounted for by industry j. T_j was obtained from the 1977 Chilean input-output table. Q_j and B_j are judgemental.

ψ_{1q} Respectively the share of aggregate employment accounted for by occupation q and the share of the economy's aggregate capital ψ_{2j} stock in industry j. The percentage share of skilled (52.2) and unskilled (47.8) workers was obtained from República de Chile, encuesta nacional del empleo. Values for ψ_{2j} were calculated by using information given in the 1977 Chilean input-output table.

Table A3 continued Coefficients of the Chilean Model

S_c S_i S_g S_c S_m	Respectively the shares of GDP accounted for by aggregate consumption, investment, other (mainly government) domestic, export and import demand. The shares, which sum to unity, were obtained from the 1977 Chilean input-output table.
$S^{(1)}_{(is)j}$ $S^{(2)}_{(is)j}$	Shares of good i from source s (domestic or imported) in industry j's purchases of i for current production (1), and capital creation (2). Obtained from the 1977 Chilean input- output table.
$S^{(3)}_{is}$	Share of the value of good i from source s in the total purchases of good i by households. Obtained from the 1977 Chilean input output table.
S_{vj} $S_{1,q,j}$	Respectively the share of primary factor v in the total primary factor costs of industry j and the share of labour by occupation q in industry j's total labour costs. Obtained from the 1977 Chilean input-output table.
$H^{(1)}_{(is)j}$ $H^{P}_{1,q,j}$ H^{P}_{2j} H^{P}_{3j} H^{T}_{j}	Respectively the shares of industry j's production costs represented by intermediate inputs of good i from source s, labour inputs of occupation q, fixed capital, land, and net indirect taxes. Obtained from the 1977 Chilean input-output table.
$B^{(1)}_{(i1)j}$ $B^{(2)}_{(i1)j}$ $B^{(3)}_{i1}$ $B^{(4)}_{i1}$ $B^{(5)}_{i1}$	Respectively the share of the total sales of domestic good i absorbed by, inputs to industry j for current production (1), and for capital creation (2), by households (3), exports (4), and other (mainly government) demands (5). Obtained from the 1977 Chilean input-output table.

Table A3 continued Coefficients of the Chilean Model

$B^{(1)}_{(i2)j}$ $B^{(2)}_{(i2)j}$ $B^{(3)}_{(i2)}$ $B^{(5)}_{i2}$	Respectively the share of the total sales of imported good i absorbed by, inputs to industry j for current production (1) and for capital creation (2), by households (3), exports (4),and other (mainly government) demands (5). Obtained from the 1977 Chilean input-output table.
$B_{1,q,j}$ $S_{1,q}$	Share of the economy's employment of occupation q accounted for in industry j, and cost share of labour of type q in the economy's total labour cost respectively. Obtained from the 1977 Chilean input-output table.
$S^{(5)}_{is}$	Share of aggregate other demands accounted for by other demand for good i from source s. Obtained from the 1977 Chilean input-output table.
M_{i2} E_{i1} M E	The share of total foreign currency costs accounted for by imported good i (M_{i2}), the share of total foreign currency export earnings accounted for by exported commodity i (E_{i1}), the aggregate foreign currency value of imports (M), and the aggregate foreign currency value of exports (E). Obtained from the 1977 Chilean input-output table.
$W^{(3)}_{is}$	Expenditure weight of good i from source s in the model's index of consumer prices. Obtained from the 1977 Chilean input-output table.

Table A4 Exogenous Variable Selection and Values for Each Experiment

Variable	Number	Experiment 1	2	3	4
r_j	h	0			
k_j	h		0	0	0
n_j	h	0	0	0	0
q	1	0	0	0	0
$f_{i1}^{(4)}$ (i=1,3-8)	g-1	0	0	0	0
$f_{i1}^{(4)}$ (i=2)	1	0	-41.37	-41.37	-41.37
p_{i2}^{m}	g	0	0	0	0
t_i	g	0	0	0	0
v_i (i=1,3-6)	g-3	$\frac{10}{v_i}$	0	0	0
v_i (i=2)	1	$-\frac{10}{v_i}$	0	0	0
$x_{i1}^{(4)}$ (i=7,8)	2	0	0	0	0
f_1	1		0	0	0
ϕ	1	0		0	0
c_R	1			0	
ΔR	1	0	0		0
ℓ	1	0	0		

A set of 2g + (g-1) + h + 1 exogenous variables is common to all experiments, h + g + 4 further variables are specific for each experiment.

1) For variables labels see Table A2.

2) The model is allowed to explain exports for the major export commodities, i.e., those whose sales pattern is such that their domestic prices can be regarded as being set by their corresponding world prices. For other commodities, exports are determined exogenously with the model endogenising the corresponding export subsidy/tax variable. (Note from (13) that if v_i is exogenous then p_{i1} will tend to move with p_i^e. If v_i is endogenous then p_{i1} will move independently of p_i^e).